Charging Solution with CN951

Introduction:

CN951 can be used to provide the status indication of charging or powering to mobile phone or other devices. Using USB or AC adaptor to charge or power mobile phone or other devices, there are applications required to indicate the two distinct operating states. One of them is to indicate the charging is in progress or normal power is delivering to the load. Another state is used to indicate the end of charge or abnormal power is delivering to the load.

Detailed Circuit Operation:

CN951 requires to monitoring the current along the charging path. When the charging/loading current is greater than the upper limit threshold (Iup), the red LED light will be on which indicates the charging is in progress or normal power is delivering to the load. If the charging/loading current is below the lower limit threshold (Ilow), the green LED will be on. It indicates the charging is completed or an abnormal power is delivering to the load. Below is the application circuit for the functions mentioned.

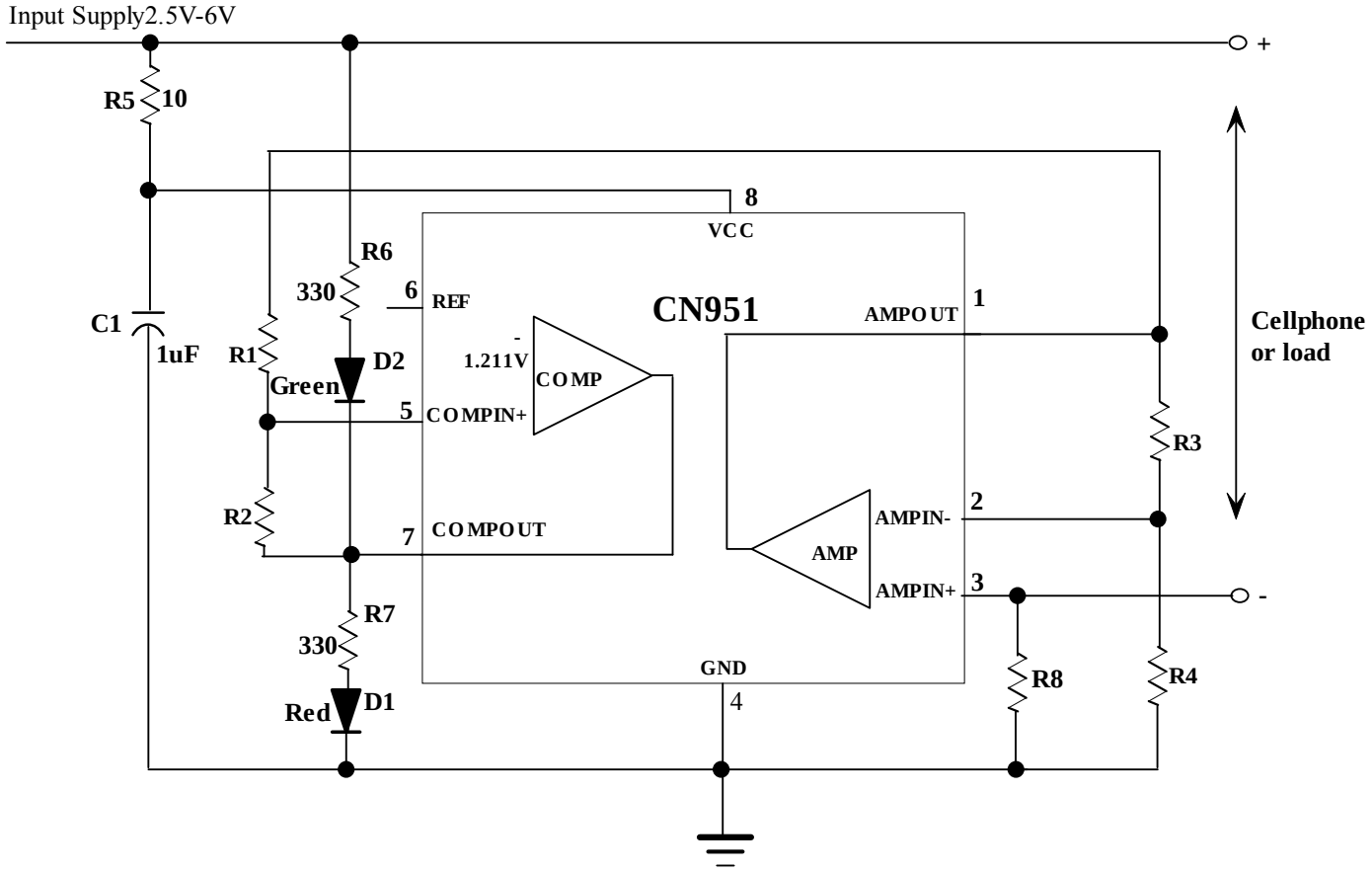


Figure. 1

Where:

- R5 and C1 form a filter circuit for the supply powering CN951;
- R8 uses to sense the charging or the loading current;
- R3 and R4 set the gain of the internal operational amplifier for magnifying the current sense signal
- R1 and R2 form a positive feedback for increasing the hysteresis of the internal comparator;

- R6 and R7 use to limit the LED current which their resistance are selected according to the requirement of the LED brightness

Component Selection：

In Figure 1, the value of R1, R2, R3, R4 and R8 can be decided as follow:

1. **Determine the Upper (Iup) and lower (Ilow) limit thresholds of the charging/loading current**

   When the charging/loading current is greater than the upper limit (Iup), it indicates the charging is in progress or there is a normal loading being detected. When the charging/loading current is less than the low limit (Ilow), it represents either the charging is completed or there is an abnormal loading being detected.

   Under normal condition, the upper limit (Iup) threshold should be selected smaller than normal charging current or normal loading requirement, and the lower limit (Ilow) threshold should be larger than the end of charge current or abnormal loading current. For example, a charging current of 500mA products, we can choose Iup = 350mA, Ilow = 50mA.

2. **Determine the resistance of R8**

   The value of R8 is based on the charging/normal loading current requirement, and the allowed voltage drop across R8. During the selection, attention should be given to the maximum power rating requirement.

3. **Determine the resistance of R3 and R4**

   The gain of the operational amplifier can be set by R3 and R4 as the equation below:

$$Av = \frac{R3+R4}{R4}$$

   It is recommended to have the gain between 5 and 20.

   The consideration will first on how much current will be flowing through R4. It is recommended this current between 5uA and 200uA. Then, the possible range of R4 can be calculated based on the following equations：

$$\frac{Iup \times R8}{R4} < 200uA$$

$$\frac{Ilow \times R8}{R4} > 10uA$$

   According to the power requirement (if any) and the target current across R4, R4 can be calculated. Based on the gain of the operational amplifier requried, the value of R3 can be determined.

4. **Determine the resistance of R1 and R2**

   The current sense signal across R8 will be amplified by the internal operational amplifier. The amplified output will be compared with the internal voltage reference. The output of the comparator will drive the LED directly to indicate the charging/loading status.

   From CN951 specification, comparator's upper threshold (Vup) is:

$$Vup = \frac{R1+R2}{R2} X (Vref+0.007)$$

   and comparator's lower threshold (Vlow) is:

$$Vlow = \frac{R1+R2}{R2} X (Vref-0.007) - \frac{R1}{R2} X VCC$$

   where internal voltage reference (Vref) is 1.211V (typ.) ± 2%.

When the output of the operational amplifier is greater than or equal to upper threshold (Vup), the red LED will be on. When the operational amplifier output is less than or equal to lower threshold (Vlow), the green LED will be on. Vup and Vlow can be calculated as follow:

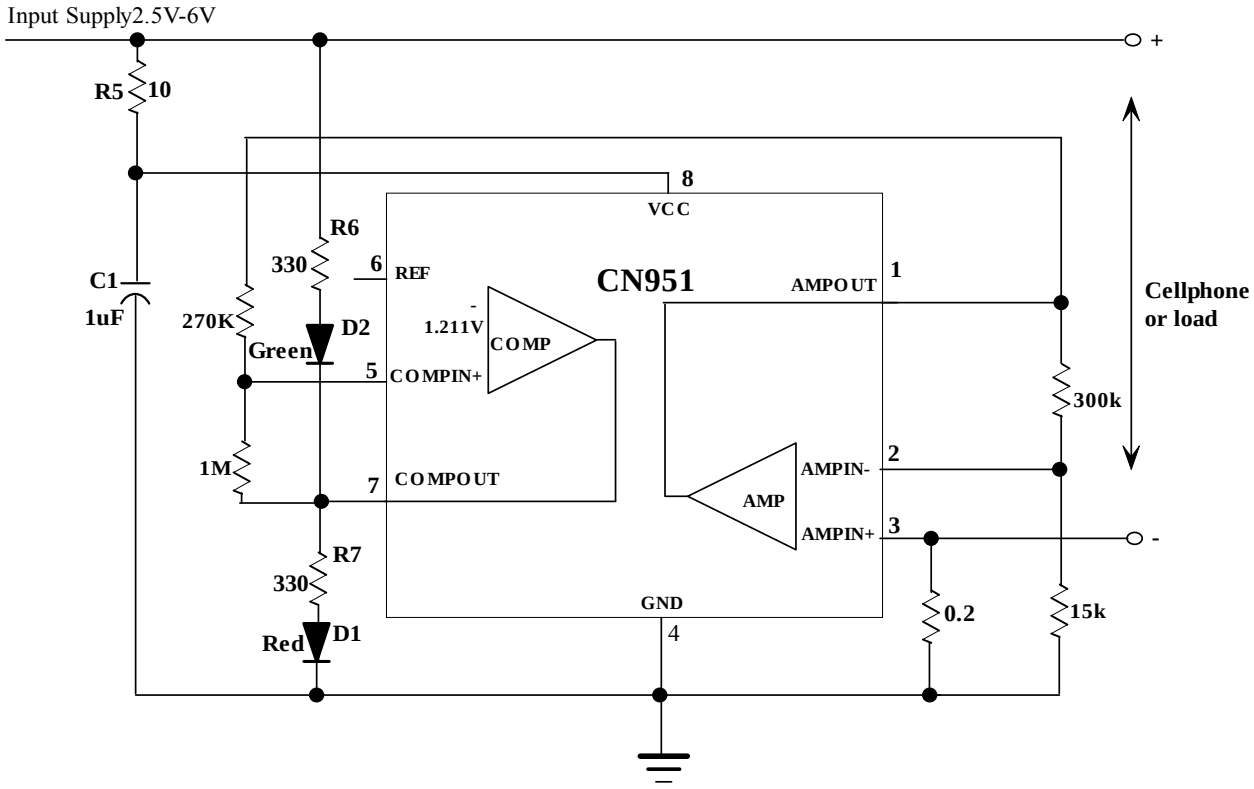
$$Vup = \frac{R1+R2}{R2} X (Vref+0.007) = \frac{R3+R4}{R4} IupR8$$

$$Vlow = \frac{R1+R2}{R2} X (Vref-0.007) - \frac{R1}{R2} X VCC = \frac{R3+R4}{R4} IlowR8$$

In case that the current consumption is important to the application, the resistance value of R2 can be selected between 1MΩ and 2MΩ, and then the resistance of R1 can be calculated according to the two equations above.

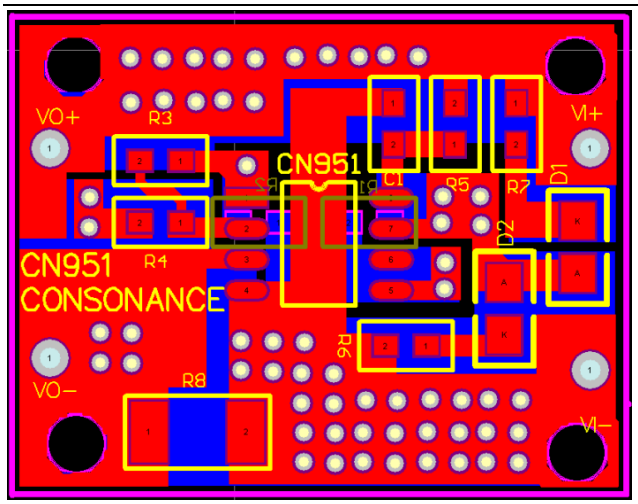
Design examples:

The requirement of the below application circuit: When the charging current is greater than 350mA, the red LED is on. When the charging current is less than 50mA, the green LED is on.



Reference PCB Design:

Please refer to the following PCB design (open with Protel).



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